CDC
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NIOSH HEALTH HAZARD EVALUATION REPORT

HETA 98-0238-2789
Spectro Coating Corporation
Leominster, MA

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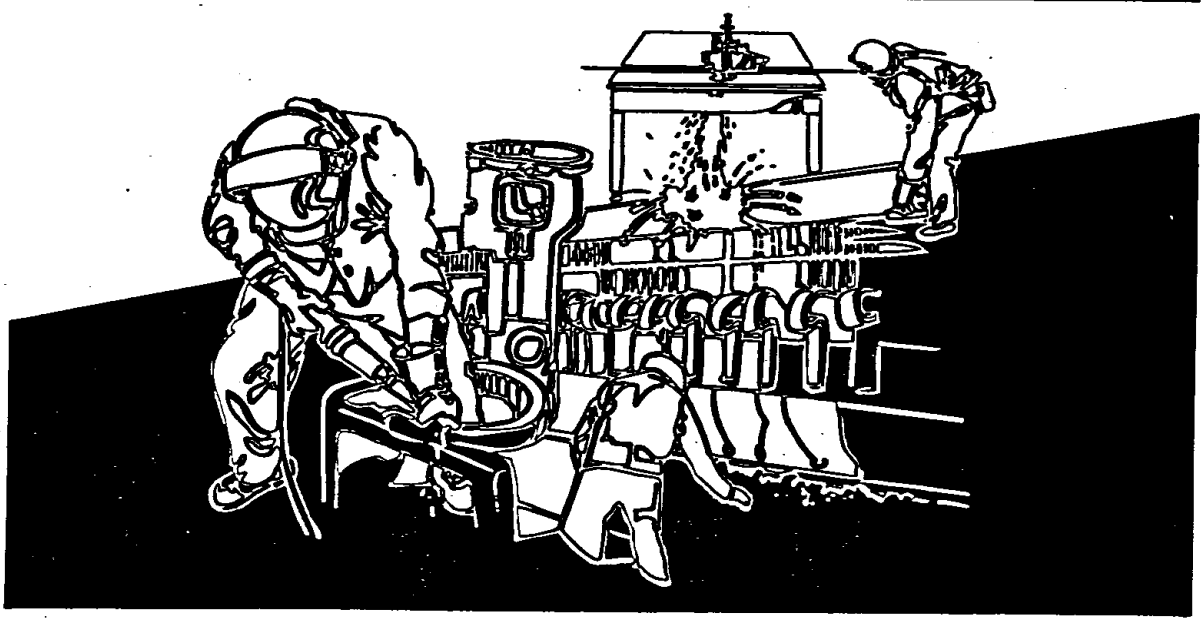

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Highlights of the NIOSH Health Hazard Evaluation at Spectro Coating Corporation

An environmental and health survey was conducted at Spectro Coating Corporation in November 1998. This evaluation was requested by management because a new lung disease (flock workers' lung) was discovered in workers at another flock plant. NIOSH measured dust exposures and their effects on the health of Spectro Coating workers.

What NIOSH Did

- Measured dust and fiber levels in several areas and for most jobs.
- Interviewed workers about symptoms and health complaints.
- Looked at the measurements and interview results for connections between the dust or fiber levels and health effects.

What NIOSH Found

- The same types of particles identified at the plant with cases of flock workers' lung (fragments of fiber and finish small enough to enter the lungs) were also present in air samples collected at Spectro Coating.
- Blow-down cleaning with compressed air and flock-loading resulted in the highest dust concentrations measured in this workplace.
- Blow-down cleaning was associated with health effects in workers.
- Smoking, especially in workers with exposures from compressed air cleaning, was associated with health effects.
- Respirators were not used regularly and many workers had not been fit-tested.

What Spectro Coating Managers Can Do

- Stop using blow-downs as a cleaning method.
- Change the flock-loading process to reduce dust exposure.
- Require respirators during compressed air cleaning (blow-downs) and in the flocking rooms until these changes are made.
- Inform workers about work-related disease observed among flock workers and how to reduce or control their risk of disease.
- Ensure that workers with frequent fever, aches, or respiratory symptoms receive a medical evaluation to determine the need for placement out of high exposure jobs.
- Implement a no-smoking policy at the plant or restrict smoking to separately-ventilated smoking areas.

What Spectro Coating Employees Can Do

- Stop smoking.
- Wear respirators when required.

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NIOSH National Institute for Occupational Safety and Health

PREFACE

Under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace upon request. These investigations, which require a written request from any employer or authorized representative of employees, are undertaken to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found. NIOSH also provides, upon request, technical and consultative assistance to Federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

Primary field investigators were Dr. Feroza Daroowalla, Dr. Mei Lin Wang, Joseph Burkhart, CIH and Chris Piacitelli, CIH of the Field Studies Branch, and Dr. William Jones of the Laboratory Research Branch of the Division of Respiratory Disease Studies (DRDS). Other DRDS staff were involved: Steve Berardinelli, Tara Hood (visiting fellow), and Dan Yereb provided industrial hygiene field assistance; Charity Camaddo (visiting fellow), Christie Kerrigan, Terry Rooney, and Rebecca Stanevich provided medical field assistance; Dr. Michael Attfield provided guidance in data analysis and interpretation; and Drs. Robert Castellan, Kay Kreiss, and William Jones conducted the initial site visit. In addition, Drs. Vince Castranova and Dale Porter of the Health Effects Laboratory Division (HELD) designed and directed toxicological studies. Desktop publishing performed by Terry Rooney.

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SUMMARY

The Spectro Coating Corporation applies flock to backing materials in one plant in Leominster, Massachusetts. The management requested a health hazard evaluation (HHE) to get a better understanding of the respiratory hazards in the plant. At the time of the request, an extensive HHE at another company's flocking facility in Rhode Island [NIOSH 1998] had uncovered a cluster of cases of a new occupational lung disease (flock workers' lung) [Kern et al. 1998]. In addition, one worker at Spectro Coating had a diagnosis of the same illness.

In November 1998, NIOSH conducted an investigation at the Spectro Coating plant consisting of a symptom and work history questionnaire and personal and area sampling, primarily for respirable dust (small enough to reach the deepest areas of the lungs) and fiber counts. Approximately 87% of the workers participated in the survey.

The results and conclusions of the survey are as follows:

- The same types of particles identified at the Rhode Island plant were also present in air samples collected at Spectro Coating. Even though the dust concentrations were lower compared to those in the Rhode Island plant, blow-down exposures at Spectro Coating were associated with respiratory symptoms in workers.
- Blow-down cleaning with compressed air and flock-loading resulted in the highest dust concentrations measured in this workplace. Blow-down exposures were associated with an excess of fever/aches and cough/phlegm. Decreasing exposures should lead to decreased symptoms and complaints.
- Gravimetric respirable dust measurement appears to be a suitable method for characterizing concentrations in this setting.
- Smoking alone and in an interaction with the exposures from compressed air cleaning was associated with symptoms.
- Respirator use was sporadic, and many workers had not been fit-tested.

The following are specific recommendations for this workplace:

- Reduce dust exposures with engineering controls.
- Until engineering controls are in place, limit the use of blow-downs and use personal respiratory protection to control dust exposures.

- Expand the annual medical examination to include a means for identifying workers with frequent fever, aches, cough, phlegm, wheezing, or other respiratory symptoms. Workers with any of these symptoms should receive a medical evaluation and an opportunity to reduce dust exposures by placement out of high exposure jobs.
- Periodically inform workers about work-related disease observed among flock workers and how to reduce or control their risk of disease.
- Implement a no-smoking policy at the plant [NIOSH 1991]. If allowed at all, smoking at the plant should be restricted to designated, separately-ventilated smoking areas. Workers should be encouraged to stop smoking altogether through an employer-sponsored smoking cessation program and education campaign.

NIOSH investigators determined that a health hazard exists from occupational exposure to flock-associated dust. This risk is characterized by the occurrence of physician-diagnosed interstitial lung disease in at least one worker, and by the results of a respiratory symptom survey that suggest an association of respiratory and systemic symptoms with conducting compressed air cleaning (blow-downs). The hazard is related to dust exposure and is found to be the greatest in the flocking room. Reduction of worker exposure to airborne dust is recommended to protect the health of the workers at this plant.

Keywords: SIC 2299 (Textile goods, Not Elsewhere Classified), nylon, fibers, flock, interstitial lung disease, flock workers' lung, respiratory irritation, particulate not otherwise classified (PNOC), particulate not otherwise regulated (PNOR).

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INTRODUCTION

In November 1997, NIOSH representatives met with the management of Spectro Coating Corporation to describe the work NIOSH was conducting in the flocking industry, including the health hazard evaluation (HHE) conducted at a flocking plant in Rhode Island [NIOSH 1998], to observe the flocking operations at Spectro Coating, to discuss the health of workers, and to inform the management about the NIOSH HHE program. At the time, one worker at Spectro Coating had symptoms and lung biopsy findings consistent with cases of illness described at the Rhode Island plant.

In May 1998 NIOSH received a formal request from Spectro Coating for an HHE to characterize dust exposures and possible health hazards. The Spectro Coating operation consists of one plant located in Leominster, Massachusetts where flock (cut nylon and other fibers) is applied to adhesive-coated fabric.

NIOSH conducted an initial site visit at the Spectro Coating facility during the week of June 15, 1998. During the week of November 8, 1998, a respiratory symptom and work history questionnaire was administered, and environmental measurements of airborne dust and fibers were obtained. The survey aimed to identify operations which may result in excessive dust exposures, to identify the association of workplace exposures with respiratory health outcomes, and to recommend ways to reduce exposures.

This report presents the results from the medical and industrial hygiene surveys, including analysis of the relationship between symptom prevalence and dust and fiber measurements. In addition, recommendations for preventing occupational lung disease are made.

BACKGROUND

PROCESS DESCRIPTION

Spectro Coating Corporation purchases 50-pound bags of flock—cut fiber, usually 10-15 micrometers (μm) in diameter and 1 millimeter (mm) long—and applies it to backing materials. Application of flock onto the backing material takes place at the flocking ranges. A water-based latex adhesive compound is poured onto the backing material (usually rolled polyester/cotton fabric, but sometimes vinyl, or foam). In the flocking room, the backing enters an enclosed flocking module where loose flock from hoppers enters from above. An electric field with alternating current in the module aligns the flock at right angles to the surface of the backing material. After the flock has been applied, the product is heat-cured, brushed, and vacuumed to remove loose flock, inspected, and spooled in various lengths. The roll of material may receive additional treatment in offline areas, such as embossing or wrinkling, or it may go directly to the shipping department.

The Spectro Coating plant contains several separate flocking ranges. The majority of the flock used at the facility is nylon but other types such as rayon, polyester, cotton, aramid, and acrylic are also processed. Backing materials that require a precoat of adhesive may receive it at the precoating range or at one of the flocking ranges with in-line precoating capabilities. Hoppers of loose flock in the flocking rooms must continually be replenished manually from 50-pound bags of flock. Prior to a product changeover at a flocking range, a cleaning process referred to as a 'blow-down' takes place. In this process workers use compressed air guns to blow settled flock from within and on equipment and floors in the flocking rooms. The thoroughness of the blow-down, and thus the duration, which can be from less than an hour to several hours, is dependent on the tolerance for some contamination of foreign flock on the next product.

DISEASE CHARACTERISTICS

A lung disease in nylon flock workers has recently been recognized and named 'flock workers' lung' [NIOSH 1998, Kern et al. 1998]. This interstitial lung disease (ILD) affects the area of the lung where oxygen and carbon dioxide are exchanged between the air and the blood. Flock workers' lung is characterized by cough and shortness of breath, changes on chest computed tomogram (CT scan), a decrease in the volume of air the lungs can hold (restriction), reduction in capability to exchange oxygen and carbon dioxide, and a characteristic tissue biopsy appearance (collections of white cells called lymphocytes around the airways). In addition, some affected workers complain of wheezing and phlegm production and have a decrease in the rate at which air can be blown out of the airways. The latter suggests involvement of the airways in the disease, or a separate occurrence of airways disease in these workers. Frequent fever and ache were reported by some of the workers who had biopsy-documented disease. Features of flock workers' lung include a variable time period between the start of exposure and onset of disease, its reversible nature upon removal from exposure, and possible recurrence with re-exposure [NIOSH 1998, Kern et al. 1998].

Lung tissue biopsies of individuals with flock workers' lung show a concentration of inflammatory cells (lymphocytes) in the walls of the smallest, most distant airways (respiratory bronchioles) [Eschenbacher et al. 1999]. Inflammation in these areas implies exposure to particles that can reach the distant airways (i.e., with an aerodynamic diameter of approximately 5 micrometers (μm) and smaller).

Flock workers' lung is probably related to respirable components of dust generated in flocking operations. Flock itself is too large to reach the respiratory bronchioles; however, the cutting of flock results in respirable shreds. In addition to fiber shreds, the respirable dust in these operations also contains cellulose particles and components of 'flock finish' [NIOSH 1998, Burkhart et al. 1999]. The studies to date have implicated nylon operations. Disease associated with other materials (rayon, polyester, and acrylic) has not been demonstrated.

Investigations in laboratory animals indicate that airborne dusts from nylon flocking operations cause acute inflammatory reactions in the airways and air sacs [Porter et al. 1999]. The animal studies to date have involved a single intra-tracheal instillation of preparations containing airborne dust. Since this type of exposure has limited resemblance to human exposures, conclusive evidence of the specific etiology of inflammation and disease in humans does not exist. Investigations of animal reactions to dusts from flocking operations that utilize materials other than nylon have not been conducted.

Besides cases of flock workers' lung, the Rhode Island investigation uncovered workers experiencing work-related chest symptoms; nosebleeds; and irritation of throat, eyes, and sinuses [NIOSH 1998].

METHODS

A NIOSH information sheet about the survey and an invitation to participate were distributed by management to all workers at Spectro Coating. Volunteers were asked to read, discuss, and sign an informed consent before participation.

ENVIRONMENTAL SURVEY

Environmental measurements of airborne particulate were obtained during the day shifts of November 12-13, 1998. Only nylon-flocked material was being produced at the flocking ranges. We made personal and area measurements for respirable particulate using NIOSH method 0600 with nylon cyclones at a flow rate of 1.7 liters per minute [NIOSH 1984], fiber counts using NIOSH method 7400, and flock fiber counts. Because we were sampling particulate that was not well characterized, we used both the A- and B-counting rules included in the 7400 method. A major difference is the diameter limit included in

the B-rules. Area measurements were also made for total (NIOSH method 0500) and thoracic dust (NIOSH method 0600 with BGI® stainless steel cyclone at 1.8 liters per minute). Real-time measurements were made for dust using MIE® personal DataRAM® light-scattering monitors. During a subset of these real-time measurements, video recordings were made in an effort to relate workplace dynamics to dust concentration.

MEDICAL SURVEY

Trained interviewers administered the questionnaire. It included modified questions on symptoms from the American Thoracic Society respiratory disease questionnaire [Ferris 1978], as well as questions on past medical history, smoking status, current job title, and past jobs in the flock industry (Appendix). We also asked workers about respirator use and whether fit-testing had been conducted.

DATA ANALYSIS

We entered data into electronic form using double entry verification techniques and used SAS and SPSS statistical programs for analysis of responses from all participants. Exposure measures, outcome measures, and confounders were defined both *a priori* (i.e., prior to examination of the data) and using *post hoc* (i.e., after examination of the data) determinations. The significance of the association between exposures and outcomes are reported as probability *(p)* values. Values less than 0.05 are considered to represent an association that is not likely to be due purely to chance.

Exposure Measures

Exposure variables for the analysis were derived in three ways: 1) using measured current dust and fiber (A-rules) concentrations categorized into high, medium, or low; 2) using cumulative exposures based on dust-time or fiber-time parameters; and 3) categorical variables (yes-no) for the performance of particular tasks. The tasks that were *a priori* thought to involve high exposures were blow-downs in current and past jobs, and loading flock hoppers in the flocking room. Use of respirators was not included in the analysis because of the incomplete and sporadic pattern of use among workers at Spectro Coating.

Current and cumulative exposure estimates: Each personal sample for respirable dust and fibers was linked to a job by observation during sampling. One or more samples were taken for each job. The average (arithmetic mean) of all samples from a particular job was calculated. Non-detectable samples were assigned the value of half the minimum detectable concentration and were calculated into the average [Hornung and Reed 1990]. We designated this average as the representative summary measure of exposure for all workers in that particular job. All workers in any given job were assumed to have that same exposure during the time they were in that job.

In order to compare workers with different current exposures, we divided the study population into three groups each for dust and fibers: those with jobs with high current exposures, medium current exposures, and low current exposures. The division into high, medium, and low categories was made using natural break points in the average concentrations to create similar group sizes.

Cumulative exposure for each worker for all work in the flock industry was calculated by summing the products of average dust (or fiber) measurement for each job and time (years) spent in each job. Estimates of exposures in past jobs at Spectro Coating and jobs in other companies were made using concentrations measured in November 1998. Workers with cumulative exposure (yrs-mg/m^3 or yrs-fibers/cm^3) greater than the median were compared with workers with cumulative exposures below the median. We chose the median over the mean as the measure of central tendency because the distributions of cumulative exposures were skewed.

Exposure to specific tasks: The other exposure measures that were used in the analysis are defined here.

Blow-downs in current job: The term blow-down refers to the cleaning of equipment and work space with compressed air. There was wide variation in the number of blow-downs reported by workers. Some of these reported blow-downs referred to the cleaning of clothing—an operation we had not characterized with environmental sampling. Therefore, in order to make the best use of the information regarding the numbers of blow-downs conducted, we used this term as a categorical variable rather than as a continuous variable. We divided workers into three groups: 1- workers who did no blow-downs; 2 - workers who did less than 10 blow-downs in an average week; and 3 - workers who conducted 10 or more blow-downs in an average week. The first two groups were similar in their relationships with the outcomes in preliminary analysis and so were collapsed into one.

Blow-downs in past jobs: This was used as a categorical (yes-no) variable, and any worker who had worked in a past job at a flocking range as an inspector, utility man, flockman, or team leader was put in this group. Although other workers may have conducted blow-downs as well, these are the jobs in which workers would most likely have conducted blow-downs on a consistent basis.

Flock-loading into hoppers: This variable, expressed as a categorical variable, was explored but was not used in the final analysis because it was not associated with symptoms.

Outcome Measures

The health outcomes we examined in this analysis were symptoms and symptom complexes. The prevalences of cough, phlegm, shortness of breath, wheezing, eye, throat, nose symptoms, fever and aches were determined. Symptoms were also combined into complexes to serve as indicators of disease processes, including mucous membrane irritation, bronchitis, interstitial lung disease (ILD), asthma, and systemic inflammation. Although symptoms are not always specific indicators for single disease processes, they are a sensitive and useful indicator of lung health. We have used them in the absence of objective health data.

Symptom complexes: The symptom complexes were chosen *a priori* and represent the types of outcomes that are expected in workers in a flocking operation, based on the literature and previous investigations:

Mucous membrane irritation (MMI): This complex is defined as having three or more episodes in the last 12 months of eye irritation or of throat irritation, soreness, or tickle. Eye or throat irritation may be caused by large particles that are airborne in the environment. These symptoms were examined because of similar complaints in another flocking plant [NIOSH 1998], their potential for being precursors to lower airway disease, and their contribution to discomfort and absenteeism in workers.

Bronchitis-like symptoms: This complex is defined as cough and phlegm. These symptoms were reported by some workers with flock workers' lung, and can accompany the chronic inflammatory changes in larger airways that were seen on biopsies of flock workers' lung. Cough is defined as a report of usually coughing as much as 4-6 times per day for 4 or more days out of the week (usual cough) or cough on most days 3 or more consecutive months of the year (chronic cough). Phlegm is defined as phlegm twice a day, 4 or more days of the week (usual phlegm), or phlegm on most days 3 or more consecutive months of the year (chronic phlegm).

ILD-like symptoms: This complex is defined as shortness of breath (SOB) and cough. These symptoms have been reported by workers with flock workers' lung. SOB is defined as having no musculo-skeletal reason for difficulty walking and being troubled by shortness of breath when hurrying on level ground or walking up a slight hill, or having

to walk slower than people of one's own age on level ground because of shortness of breath. Cough is defined in the same way as described for bronchitis-like symptoms.

Asthma-like symptoms: This complex is defined as chest sounding wheezy or whistling most of the time or having an attack of wheezing that has made one feel short of breath. Wheezing implies swelling and narrowing of the airways and has been reported by workers in flock plants.

Systemic symptoms: This complex is defined as three or more episodes of fever or flu-like achiness in the last 12 months. These symptoms can be related to an inflammatory response to materials in the environment and were reported by workers in flock plants, including some of those with flock workers' lung.

Other health outcomes that were deemed important after preliminary examination of the data were also examined.

Multivariate Analysis

In order to examine the association of exposure measures with health outcome measures, while taking into account the potential effects of other factors such as smoking, we conducted multivariate analyses. Potential confounders of the relationship between exposures and the health outcomes were smoking (which was expressed both as current/never/former smoker and as a measure of pack-years smoked), age, and history of asthma or hayfever that occurred prior to starting work in flock. Additionally, we explored the interaction between smoking and current participation in blow-downs. This interaction term was not used as a variable in the final multi-variate models because of small numbers.

Never smokers were defined as those that reported never having smoked regularly (less than 100 cigarettes in entire life). Current smokers were defined as those who reported smoking cigarettes at the time of the survey. Former smokers were those that reported having stopped smoking after a period of regular smoking. Former smokers and never smokers were collapsed into the same category after preliminary analysis did not show major differences between them. A worker was considered as having a history of asthma or hay fever if he or she reported a doctor-diagnosis of either, and the year of onset preceded the year of first work in the flocking industry.

RESULTS

Of the 98 employees at Spectro Coating at the time of the NIOSH survey, 86 (87%) volunteered to answer the medical questionnaire. Thirty-nine of the day shift workers wore environmental sampling equipment, most on both days (November 12-13, 1998). Three of the workers sampled did not complete the medical questionnaire.

WORKER CHARACTERISTICS AND JOB TITLES

Table 1 shows the gender, race, smoking, and other characteristics of the 86 workers who were interviewed. Most of the workers interviewed were male and identified themselves as being white. About half of them were smokers at the time of interview. Workers reported that they usually work 60 to 72 hours in a work-week of 4 to 6 days and 91% had been in their current job for greater than 6 months (mean time in current job 3.6 years). The interviewed workers had worked in the flock industry in general for a mean of 6.9 years (range 0.3-25.6 years) and at Spectro Coating in particular for an average of 5.5 years (range 0.3-25.6 years).

About 45% of the workers were engaged in tasks that *a priori* were thought to involve high exposures (blow-downs with compressed air and flock-loading into hoppers). Thirty-nine workers reported that they conduct blow-downs. The number of blow-downs varied widely but eleven workers conducted more than 10 blow-downs in an average week. Thirty-three of 39 workers (85%) who conducted blow-

downs wore a respirator (single strap disposable, 2-strap disposable, or half-face cartridge) while conducting some of the blow-downs. Fit-testing for respirator use was not common. Most of the workers who conducted blow-downs worked in the flocking area (flockman, utility man, range inspector, team leader on ranges). Thirty-one of these workers also worked near blow-downs that they did not directly conduct. Nine others (mechanics, precoaters and material handlers) reported being exposed only as a result of working near blow-downs conducted by other workers. Most (35/40, 88%) workers did not wear a respirator when blow-downs were occurring near their area.

Thirty-nine workers reported that they spent time loading flock (emptying bags) into hoppers in the flocking room. Of these, 28 (72%) reported that they wore respiratory protection during some or all of the task. Most of the workers who loaded hoppers reported their job title as flockman, inspector, utility-man, team leader, or headman on the flock ranges.

Workers reported doing jobs with rayon, polyester, cotton, aramid, and acrylic in addition to nylon. Among those workers not primarily in administrative positions, 49% reported that they had worked with polyester in the last year, 58% with rayon, 59% with cotton, 46% with acrylic, and 14% with aramid.

Table 2 shows the current job as reported at the time of the interview. Nineteen percent of the workers interviewed primarily spent their time in office or administrative tasks.

ENVIRONMENTAL RESULTS

Figure 1 shows area respirable dust levels measured gravimetrically. The line through the bar indicates the standard error of the mean. Eight samples were collected in the flocking room (two during blow-downs and the remainder during flocking), and four were collected elsewhere in the plant (offline, shipping, and offices). The dust levels in the flocking room, especially during blow-down, dwarf those found in other areas of the plant. Figure 2 provides area results for all measures of exposure.

The measures of dust follow the expected pattern with total dust being highest, followed by thoracic and respirable. The respirable particulate concentration was about half that of thoracic and the measures were highly correlated ($r = 0.99$) with each other. Average fiber counts were about 3.0 and 2.5 fibers per cubic centimeter (fibers/cm^3) for A- and B-rules counts, respectively (correlation between A- and B-rules counts was 0.99). A-rules counts also correlated well with respirable particulate ($r = 0.96$), with 5.6 fibers/cm^3 corresponding to 1 milligram per cubic meter (mg/m^3).

Personal respirable dust levels by job are provided in figure 3A. The samples were collected over approximately an eight-hour period with the exception of those obtained on workers who performed blow-downs. Their sampling filters were replaced before and after that task. Most of the respirable dust concentrations were below 0.1 mg/m^3 - all were under 1.7 mg/m^3. Only six sample concentrations exceeded 0.4 mg/m^3 - two of those were above 1.0 mg/m^3. The higher concentrations were mostly measured on flockmen performing blow-down cleaning operations in a flocking room. However, the fourth highest concentration was found on a flockman who did not participate in blow-downs during the sampling period. When not conducting blow-downs, flockmen repeatedly entered the flocking rooms to load flock into the module hoppers and exited after completing the task. During these non-cleaning operations flockmen experienced concentrations generally higher than the remainder of the workers in the plant. Personal fiber concentrations (A-rules counts) are presented in figure 3B. The correlation between these fiber concentrations and personal respirable dust concentrations was 0.83 (5.7 fibers/cm^3 = 1 mg/m^3). A-rules counts were 1.2 times the B-rules counts ($r = 0.99$)

Figure 4 shows real-time personal breathing zone dust data collected during one of the many times in a shift when a flockman emptied bags of flock into a module hopper. The initial flat portion of the graph is the reading when the worker was outside the flocking room and in the vicinity of the adhesive

coating heads. The subsequent sharp rise is associated with the worker entering the room. The response of the monitor during the few minutes he emptied a bag is depicted under the first bar in the figure. Visible plumes of flock were observed both when the worker lifted and emptied the bag into the hopper opening and when he scooped flock from the bag with his hands. The highest peak on the graph represents a plume of flock which rose towards the worker's face during one of the scooping motions. Interestingly, the next elevated portion of the graph, following a brief exit from the room, occurred while the worker cleaned himself off with a compressed air gun while standing in the doorway.

Figure 5 presents the concentration measured by a monitor worn by one of two workers cleaning a flocking room with compressed air (blow-down). The highest peaks correspond to times he was observed inside a visible plume of dust generated by his co-worker or himself while blowing flock from equipment.

Concerning the nature of the airborne dust in this plant, figure 6 is a scanning electron microscope image from an air sample collected in the flocking room during nylon flocking. The sample included particles of flock (the large fiber in this image) and a variety of small particles. A subset of the small particles were elongated. The elongated particles were found to be predominantly shreds of synthetic material formed during the cutting and milling of the flock. The more compact particles were generally fragments of the various finish components.

EXPOSURE GROUPS

Workers were placed into three groups according to average concentrations of respirable dust or fibers (A-rules counts). For respirable dust, the three groups were formed as follows: The high exposure group (greater than 0.062 mg/m^3) included flocking inspector, maintenance worker, and flockman. The medium exposure group (less than 0.062 and greater than 0.04 mg/m^3) included flocking area head man, team leader, and utility man. The low exposure group (less than 0.04 mg/m^3) included office-administration staff, material handler, laboratory and quality control worker, offline inspector, janitor, and offline team leader. For fiber concentration, the groups were as follows: The high fiber exposure group (greater than 0.11 fibers/cm^3) included offline inspector, flocking area team leader, utility man, and flockman. The medium fiber exposure group (less than 0.07 and greater than 0.04 fibers/cm^3) included flocking area inspector, janitor, offline team leader, flocking headman, maintenance worker, and material handler. The low fiber exposure group (less than 0.04 fibers/cm^3) included office-administration staff and lab and quality control worker. Exposure levels measured during blow-downs were not included in the averages. Participation in blow-downs is used as a categorical (yes-no) variable in the analysis.

SYMPTOM PREVALENCE

Frequency of symptoms according to smoking status (at the time of the interview) is presented in table 3. The prevalences of eye, throat, and sinus symptoms exceeded that of reported hay fever and did not consistently follow a pattern related to smoking habits. Only eye irritation was found to have a pattern of work-relatedness (based on questionnaire response): It was reported to usually occur on work days by 59% (10/17) of the workers who had that complaint. Chronic cough (cough on most days 3 or more months during the year) was highly correlated with smoking status. Usual cough (4-6 times a day for 4 or more days out of the week) followed the same pattern of prevalence as chronic cough. Phlegm was related to smoking status, and this is a known effect of smoking on the airways. Chronic phlegm (most days for 3 or more consecutive months) and usual phlegm (twice a day, 4 or more days out of the week) had a similar pattern of prevalence. There was a relationship of shortness of breath (SOB) when walking up a slight hill with smoking habits. SOB compared to those of own age was much less prevalent than SOB with walking up a slight hill. Occasional wheezing in the absence of a cold was associated with smoking status. Wheezing most of the time and wheezing with attacks of shortness of breath were much less prevalent, and a relationship with smoking status was

not evident. Fever and aches were more frequent among current smokers in this group.

SYMPTOM COMPLEXES

Table 4 shows the frequency of symptom complexes and smoking status according to exposure category. This table should be read down the column for each symptom complex to compare low or no exposure groups with higher exposure groups. Results of multivariate analysis, where all the exposure measures and other variables are taken into account, are shown in statistically significant cases. Overall, there is no statistically significant difference in the smoking status of workers within each exposure category.

Mucous membrane irritation (MMI): There were no statistically significant associations between exposure measures and this symptom complex either in univariate or multivariate analysis for respirable dust or fiber concentrations. Nor was there an association when we examined cumulative exposure to large airborne fibers (years-flock fibers/liter) in a multivariate model.

Bronchitis-like symptoms: Current smokers were more likely to have both cough and phlegm although this association was not statistically significant. Workers who conducted blow-downs in their current jobs were more likely to have these symptoms than workers without this exposure (table 4). When we examined the interaction of doing blow-downs and current smoking, we found that a worker who had both these exposures had a higher likelihood of developing bronchitis-like symptoms than a worker with just one of these exposures (table 5).

ILD-like symptoms: Shortness of breath and cough were associated with current smoking in univariate and multivariate analysis. Although the association was not statistically significant, symptoms were more likely to occur when exposure to blow-downs in the current job was present than when it was not (table 4). The effect of a combination of smoking and exposure to blow-downs in the current job was even more pronounced (table 5).

We also examined shortness of breath and cough and phlegm occurring together. This was a rare event seen in 5 workers (6%) only. However in multivariate analysis, it had some association with blow-downs in current job (Odds Ratio =6.1, p=0.07) and this association was stronger when exposures included both smoking and blow-downs in current job (table 5).

Asthma-like symptoms: Wheezing most of the time or with attacks of SOB had some association with exposure to blow-downs in the current job or in past jobs but this did not reach statistical significance (table 4). This complex was most associated with a diagnosis of asthma or hayfever made before beginning work in the flocking industry (Odds Ratio = 6.2, $p = 0.01$).

Systemic symptoms: Fever and aches were closely associated with current smoking status. In multivariate analysis, there was an association such that those who had done blow-downs in past jobs were more likely to have these symptoms than those without these exposures (table 4).

DISCUSSION

This evaluation at Spectro Coating extends the exposure characterization in the U.S. flocking industry that was begun in the HHE at Rhode Island [NIOSH 1998]. The evaluation at the Rhode Island plant found that flock cutting and application results in a respirable dust which is highly inflammatory in rat lungs and probably incites inflammation in the human lung as well. The dust from flocking operations has been found to contain shreds of fiber (tow), most likely formed during the cutting process [NIOSH 1998, Burkhart et al. 1999] and then liberated when the flock is milled, dried, screened, bagged, and poured.

In the exposure characterization at Spectro Coating, we used gravimetric dust measurements to indicate all particles within different size categories (respirable, thoracic, and total). Fiber counts were

added as a preferential measure of the elongated particles. The results of gravimetric respirable dust measurements correlated well with the fiber counts when compared side-by-side in various areas of the plant. Additionally, when we examined relationships with outcomes, one measure was not more tightly associated with symptoms than the other. Fiber counting is more difficult and is subject to high counter variability. Because of this, and the fact that gravimetric analysis measures all particles, gravimetric measurement seems the better choice for characterizing exposures. With reference to the appropriate size-selective criteria for gravimetric measurements, there is a high correlation between measures of thoracic dust and respirable dust, and this, coupled with the wide availability of respirable dust samplers, indicates that this latter method is a good choice for industry sampling.

Microscopy indicated that the particulate at the Spectro Coating plant was *qualitatively* similar to that found at the Rhode Island plant. The *quantity* of airborne dust at the Spectro Coating plant was visibly and measurably lower. The average respirable dust level measured in the flocking rooms of the Rhode Island plant was greater than 5 mg/m^3 [NIOSH 1998]. Concentrations measured at Spectro Coating were all below 2.0 mg/m^3. Nonetheless, there was a worker with ILD at the Spectro Coating plant, and that worker's occupational history indicates that he worked in areas and performed tasks associated with potential for elevated dust levels.

Furthermore, in animal (rat) studies, an inflammatory response was seen when size-selected bag house dust from Spectro Coating's primary flock supplier was instilled into animal tracheas [Personal communication, Dale Porter, Health Effects Laboratory Division, NIOSH]. This response is generally similar to the highly inflammatory reactions seen in identical experiments using airborne dust in the Rhode Island study [Porter et al. 1999].

The investigation at the Rhode Island plant identified cases of ILD with unique biopsy characteristics. This condition was named flock workers' lung [Kern et al. 1998]. In that study, other workers were found to have work-related respiratory and systemic symptoms that represented either pre-clinical interstitial lung disease or other respiratory illness [NIOSH 1998]. In this study, we chose to explore symptoms that are common in ILD such as SOB and cough. We also examined phlegm, wheeze, mucous membrane irritation, fever, and aches. We wanted to identify other symptom complexes, in addition to flock workers' lung, that may be associated with exposures in this setting.

Mucous membrane irritation occurred in substantial numbers of workers. Although we did not find any statistically significant relationships with the measured exposures, workers did report that eye irritation usually occurred on workdays.

Bronchitis-like symptoms (cough and phlegm) were associated with conducting blow-downs. This is not surprising given the high dust exposures during the blow-down activity. The dust generated during these activities can cause irritation and inflammation of the mucous membranes of both small and large airways and results in these symptoms.

SOB and cough (the ILD-like symptoms) were not statistically associated with any of the exposure measures. Few workers had this combination of symptoms (8/86 = 9%), and this small number makes any existing association with exposure difficult to detect. Another probable reason for the lack of strong association is that these symptoms usually accompany advanced lung disease which is not likely to be found in current workers (i.e., seriously ill workers may have left the plant).

We examined a restrictively defined set of asthma-like symptoms—wheezing most of the time or with attacks of SOB—and found it in 15 persons. Most of these workers (12/15) had their first episode after they began work in the flocking industry but most (11/15) did not have a doctor's diagnosis of asthma. This suggests that workers were developing work-related asthma-like symptoms but these individuals were not seeking care or were not identified by a

doctor as being asthmatic. Additionally, multivariate analysis showed that asthma-like symptoms were more likely to develop in workers with a history (pre-dating work in the flock industry) of asthma or hayfever.

Systemic symptoms of fever or aches occurred in 14 workers (16%) and were highly associated with conducting blow-downs in past jobs. Fever and aches have been reported at other plants by workers with flock workers' lung. Although some mis-classification of viral influenza or other infectious diseases may have occurred, the strong relationship with the exposure history suggests that the workers who were experiencing unusual and frequent fevers or aches were manifesting an inflammatory reaction to exposures at work.

Smoking was an important contributor to morbidity in this population and had a strong association with several symptom complexes. In addition, there appeared to be a combined effect of smoking and exposures that occur during blow-downs on the lungs of workers who did both. The literature supports the association of smoking with airway inflammation, obstruction (asthma, chronic bronchitis), cough, phlegm production, wheeze, SOB (emphysema), and increased susceptibility to respiratory tract infections.

In the Rhode Island study, high exposure tasks and hours worked were predictors for respiratory and systemic symptoms. This suggested that recurrent high exposures, with little time for the lung to clear the inhaled dust in between exposures, may be the important factor for the development of the symptoms [NIOSH 1998]. In this study at Spectro Coating, we examined participation in blow-downs in current and past jobs, dust and fiber exposure in the current job, and cumulative exposures for all work done in the flock industry.

In this survey, as in the Rhode Island study, participating in blow-downs was associated with symptoms. This is plausible because, as seen by the real-time monitoring and personal dust measurements, blow-downs resulted in the highest exposures of the work-shift. Characterization of exposures for bystanders near blow-downs—and for the workers using blow-downs to clean clothing—was not conducted, but these activities were probably added opportunities for high exposures. Although loading flock into hoppers did not appear to be a significant predictor of symptom outcomes in this analysis, air sampling showed that this was another dust-generating activity. More detailed characterization of exposures during flock-loading and other tasks might clarify the association with health outcomes. The power of this study to detect associations, in addition to that found between blow-downs and symptoms, was limited by the small numbers of workers studied and the narrow range of measured exposures.

Average dust or fiber exposures in the current job were not found to be an indicator of symptom status. This lack of relationship can be due to several reasons, the most likely being that workers in jobs with high exposures (as measured currently) are the workers who can tolerate these exposures and are therefore the 'healthy workers.' Others who were less tolerant or became ill may have already left high exposure jobs. Longitudinal studies to elucidate the relationship between current exposures and chronic, sub-chronic and acute health outcomes are needed.

Cumulative exposure during all years spent by a worker in the flock industry did not seem to be as strongly associated with symptoms as participation in high exposure tasks. This is similar to the finding at the Rhode Island plant—that tenure in the plant was not associated with symptoms [NIOSH 1998]. If an association between symptoms and cumulative exposure existed, it is possible that such a relationship is obscured by the small numbers of workers in this study and the limited exposure assessment we conducted. It is possible that workers with symptoms had left the workplace and were not part of the analysis which would make this association difficult to detect.

The lower levels of dust at Spectro Coating demonstrate that low dust levels are achievable in a flocking facility under normal production and

operating conditions. Along with these lower dust levels, Spectro Coating also appeared to have a much lower rate of cases of interstitial lung disease than the Rhode Island plant. However, a comparison between case rates at the two facilities is not valid because the detailed case-finding and clinical work-up of symptomatic workers performed at Rhode Island was not done in the present investigation. Despite the lower dust levels at Spectro Coating, we demonstrated an exposure-response relationship between symptoms and high dust-generating processes, specifically blow-downs.

Respirable dust levels measured in this plant were below the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) of 5 mg/m^3 for particulate not otherwise regulated (PNOR) and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 3 mg/m^3 for particulate not otherwise classified (PNOC) [CFR 1999, ACGIH 1999]. However, these are not appropriate standards for this inflammatory dust. The occurrence of a case of flock workers' lung in this plant; the association of respiratory and systemic symptoms with blow-down exposures; the inflammatory nature of the dust from Spectro Coating's flock supplier in animal experiments; and the peaks of exposure during blow-downs and flock-loading support the need for further lowering of exposures in this plant.

CONCLUSIONS AND RECOMMENDATIONS

We conclude the following from this investigation:

- The same types of particles identified at the Rhode Island plant were also present in air samples collected at Spectro Coating. Even though the dust concentrations were lower compared to those in the Rhode Island plant, blow-down exposures at Spectro Coating were associated with respiratory symptoms in workers.
- Blow-down cleaning with compressed air and flock-loading resulted in the highest dust concentrations measured in this workplace. Blow-down exposures were associated with an excess of fever/aches and cough/phlegm. Decreasing exposures should lead to decreased symptoms and complaints.
- Gravimetric respirable dust measurement appears to be a suitable method for characterizing concentrations in this setting.
- Smoking alone and in an interaction with the exposures from compressed air cleaning was associated with symptoms.
- Respirator use was sporadic, and many workers had not been fit-tested.

We recommend the following for this workplace:

1. **Reduce dust exposures with engineering controls.**
   - Eliminate the use of blow-downs (compressed air) as a means of cleaning in all areas of the plant.
   - Change the flock-loading process.
   - Inspect the existing dust control ventilation system for leaks and repair as necessary.

2. **Until engineering controls are in place, limit the use of blow-downs and use personal respiratory protection to control dust exposures.**

   - Institute a formal respiratory protection program in accordance with OSHA regulations [29 CFR 1910.134].
   - Designate the flocking rooms as respirator-required areas and blow-downs as respirator-required tasks.
   - Require that a NIOSH-certified approval class N95 dust respirator be worn when in the flocking rooms.
   - Require that a full-facepiece, powered air-purifying respirator (PAPR) equipped with a high efficiency particulate air (HEPA)

filter be worn when performing blow-downs in the flocking rooms or elsewhere.

3. Expand the annual medical examination to include a means for identifying workers with frequent fever, aches, cough, phlegm, wheezing, or other respiratory symptoms. Workers with any of these symptoms should receive a medical evaluation and an opportunity to reduce dust exposures by placement out of high exposure jobs.

4. Periodically inform workers about work-related disease observed among flock workers and how to reduce or control their risk of disease.

5. Implement a no-smoking policy at the plant [NIOSH 1991]. If allowed at all, smoking at the plant should be restricted to designated, separately-ventilated, smoking areas. Workers should be encouraged to stop smoking altogether through an employer-sponsored smoking cessation program and education campaign.

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Table 1: Worker characteristics, Spectro Coating Corporation, 1998

Characteristic	Number of workers (%) n=86
Males	75 (87%)
Non-white	16 (19%)
Age in years - mean (min.-max.)	38 (22-66)
Smoking Status:	
Current smokers	42 (49%) (avg. pack years = 23)
Former smokers	20 (23%) (avg. pack years = 29)
Never smokers	24 (28%)
Day shift	65 (76%)
Performs blow-downs in current job* †	39 (45%)
Flock-loading *	39 (45%)

* The members of these two groups are slightly different.
† Eleven of these workers conduct 10 or more blow-downs in an average week.

Table 2: Current job titles of workers, Spectro Coating Corporation, 1998

Job title	Number of workers (%) n=86
Offline- Team leader*	1 (1%)
Janitor	2 (2%)
Offline- Inspector*	4 (5%)
Research and Development / Quality Control-Laboratory	6 (7%)
Flocking- Headman †	6 (7%)
Material Handler	7 (8%)
Flocking- Utilityman †	7 (8%)
Flocking- Inspector †	9 (10%)
Flocking- Team leader †	9 (10%)
Flocking- Flockman †	9 (10%)
Maintenance	10 (12%)
Office / Administrative	16 (19%)

† 'Flocking' refers to jobs at the flocking and precoater ranges.
* 'Offline' refers to jobs in the post-finish area, batching area, and at the tumbler machine.

Table 3: Prevalence of symptoms in all workers according to smoking status, Spectro Coating Corporation, 1998

Symptom	Number (%) n=86	Smoking Status		
		Current n=42	Former n=20	Never n=24
3 or more episodes in the last 12 months:				
Nosebleeds	7 (8%)	3 (7%)	2 (10%)	2 (8%)
Throat irritation	26 (30%)	15 (36%)	6 (30%)	5 (21%)
Eye irritation	17 (20%)	10 (24%)	4 (20%)	3 (13%)
Mucous membrane irritation	34 (40%)	19 (45%)	9 (45%)	6 (25%)
Sinus symptoms	32 (37%)	16 (38%)	6 (30%)	10 (42%)
Hayfever (history of doctor diagnosed)	14 (16%)	4 (10%)	5 (25%)	5 (21%)
Chronic cough	16 (19%)	12 (29%)	2 (10%)	2 (8%)
Chronic phlegm	12 (14%)	9 (21%)	1 (5%)	2 (8%)
Bronchitis-like symptoms	10 (12%)	7 (17%)	1 (5%)	2 (8%)
SOB on slight hill (and no other reason for difficult walking)	15 (20%)	11 (26%)	2 (10%)	2 (8%)
SOB compared to those of own age (and no other reason for difficult walking)	4 (5%)	2 (5%)	1 (5%)	1 (4%)
ILD-like symptoms	8 (9%)	7 (17%)	1 (5%)	0
Wheeze apart from colds	24 (28%)	18 (43%)	3 (15%)	3 (13%)
Wheeze most of the time	3 (4%)	2 (5%)	1 (5%)	0
Wheeze with SOB	14 (16%)	5 (12%)	5 (25%)	4 (17%)
Asthma-like symptoms	15 (17%)	6 (14%)	5 (25%)	4 (17%)
3 or more episodes in the last 12 months:				
Fever	5 (6%)	5 (12%)	0	0
Aches	11 (13%)	8 (19%)	1 (5%)	2 (8%)
Systemic symptoms	14 (16%)	11(26%)	1 (5%)	2 (8%)

Table 4: Prevalence of smoking status and symptom complexes in each exposure category, Spectro Coating Corporation, 1998

Exposure	n		Prevalence of symptom complex n (%)					
			Current smokers	MMI+	Bronchitis-like	ILD-like	Asthma-like	Systemic
Blow-downs in current job ++	75	No	37 (49%)	29 (39%)	6 (8%)	6 (8%)	11 (15%)	12 (16%)
	11	Yes	5 (45%)	5 (45%)	4 (36%) *	2 (18%)	4 (36%)	2 (18%)
Blow-downs in past jobs	49	No	22 (45%)	19 (39%)	4 (8%)	4 (8%)	6 (12%)	5 (10%)
	37	Yes	20 (54%)	15 (41%)	6 (16%)	4 (11%)	9 (24%)	9 (24%) **
Respirable dust in current job	36	low	13 (36%)	13 (36%)	1 (3%)	2 (6%)	5 (18%)	5 (14%)
	22	medium	15 (68%)	10 (45%)	5 (23%)	2 (9%)	4 (18%)	5 (23%)
	28	high	14 (50%)	11 (39%)	4 (14%)	4 (14%)	6 (17%)	4 (14%)
Fibers in current job	22	low	5 (23%)	8 (36%)	1 (5%)	0	3 (14%)	4 (18%)
	35	medium	23 (66%)	16 (46%)	6 (17%)	6 (17%)	8 (23%)	7 (20%)
	29	high	14 (48%)	10 (34%)	3 (10%)	2 (7%)	4 (14%)	3 (10%)
Cumulative respirable dust (yrs-mg/m³)	43	below median	21 (49%)	17 (39%)	5 (11%)	5 (11%)	5 (11%)	8 (18%)
	43	above median	21 (49%)	17 (40%)	5 (12%)	3 (7%)	10 (24%)	6 (14%)
Cumulative fiber (yrs-fibers/cm³)	44	below median	23 (52%)	18 (42%)	4 (9%)	4 (9%)	5 (12%)	7 (16%)
	42	above median	19 (45%)	16 (37%)	6 (14%)	4 (9%)	10 (23%)	7 (16%)

+ MMI refers to mucous membrane irritation which is defined as eye or throat irritation.

++ refers to 10 or more blow-downs in an average week.

* p-value of 0.02 for both univariate and multivariate models signifying an association of bronchitis-like symptoms (cough and phlegm) with conducting blow-downs in the current job. The odds ratio for the multivariate model [which takes into account smoking status, pack-years of smoking, age, pre-existing asthma or hayfever, current blow-downs, past blow-downs, current job dust concentrations, and cumulative (dust or fiber) exposure] is 6.1 (95% CI =1.3-28.5).

** p-value is 0.03 for the multivariate model signifying an association of systemic symptoms (fever and ache) with having conducted blow-downs in past jobs (odds ratio = 5.9, 95% CI =1.2-29.1).

Table 5: Symptoms related to blow-down activity in current job stratified by current smoking status, Spectro Coating Corporation, 1998

Symptom complex	No Blow-down		Blow-down		Prevalence ratio		
	No smoking n=38	Smoking n=37	No smoking n=6	Smoking n=5	Effect of blow-downs	Effect of smoking	Effect of blow-downs and smoking
Bronchitis-like symptoms	2 (5%)	4 (11%)	1 (17%)	3 (60%)	3.2	2.1	11.4
ILD-like symptoms	1 (3%)	5 (14%)	0	2 (40%)	-	4.7	15.2
Cough and Phlegm and SOB	1 (3%)	2 (5%)	0	2 (40%)	-	1.7	15.2

This table shows that for some symptom complexes, the association (represented by the prevalence ratio) to current blow-down exposure is stronger when exposure to smoking is also present.

Figure 1
Area Respirable Dust Levels

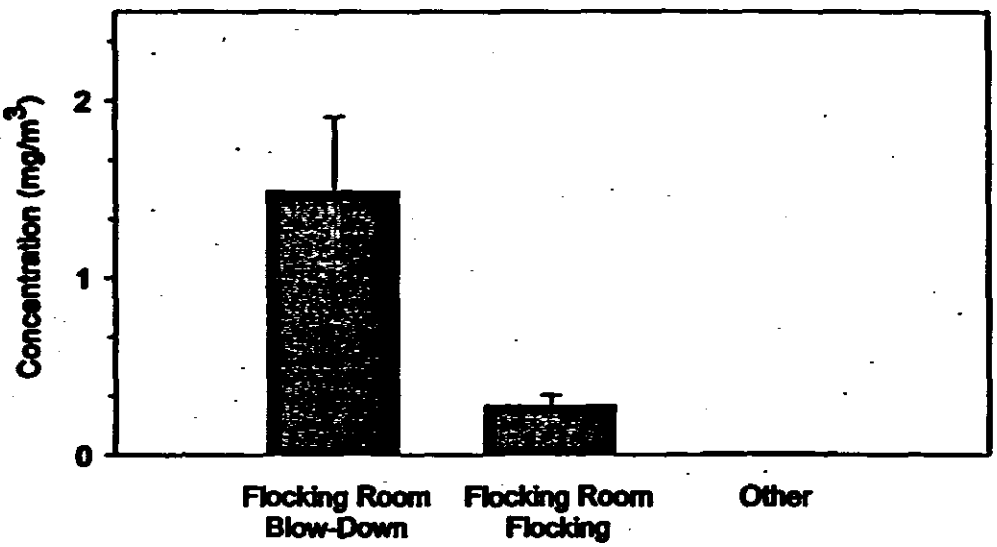


Figure 2
Comparison of Various Area Measures of Concentration

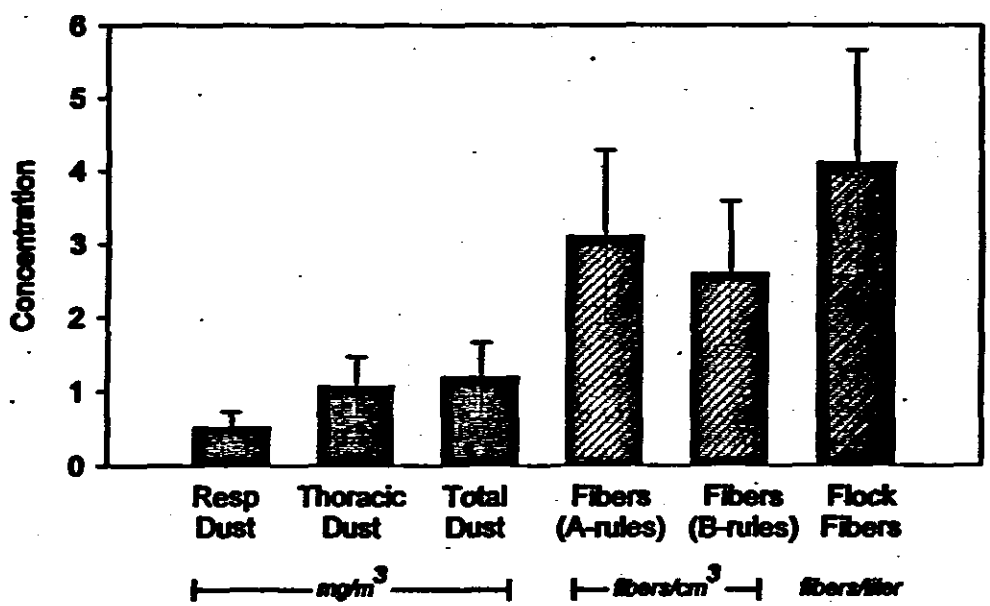


Figure 3A
Personal Respirable Dust Measurements

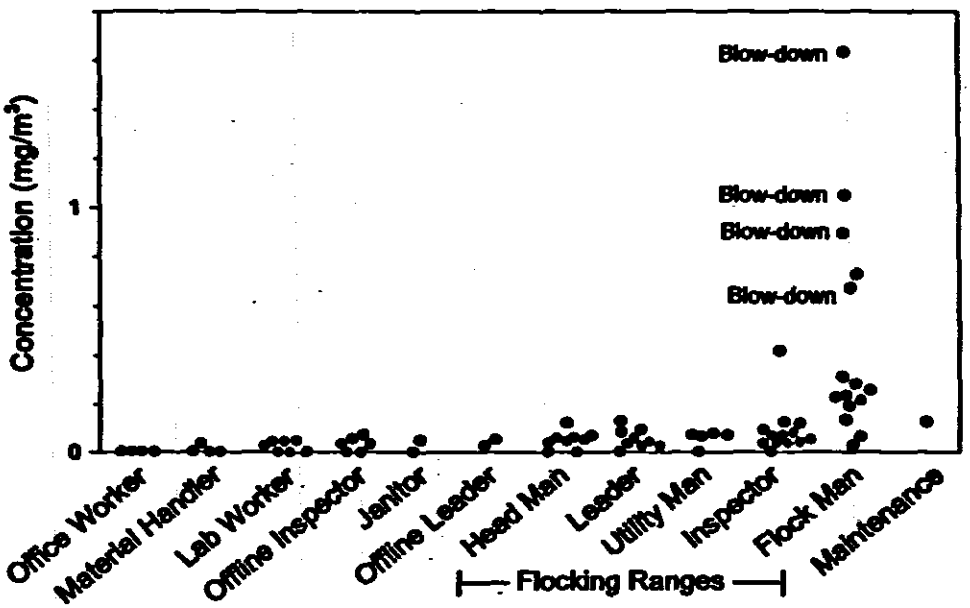


Figure 3B
Personal Fiber (A-rules) Measurements

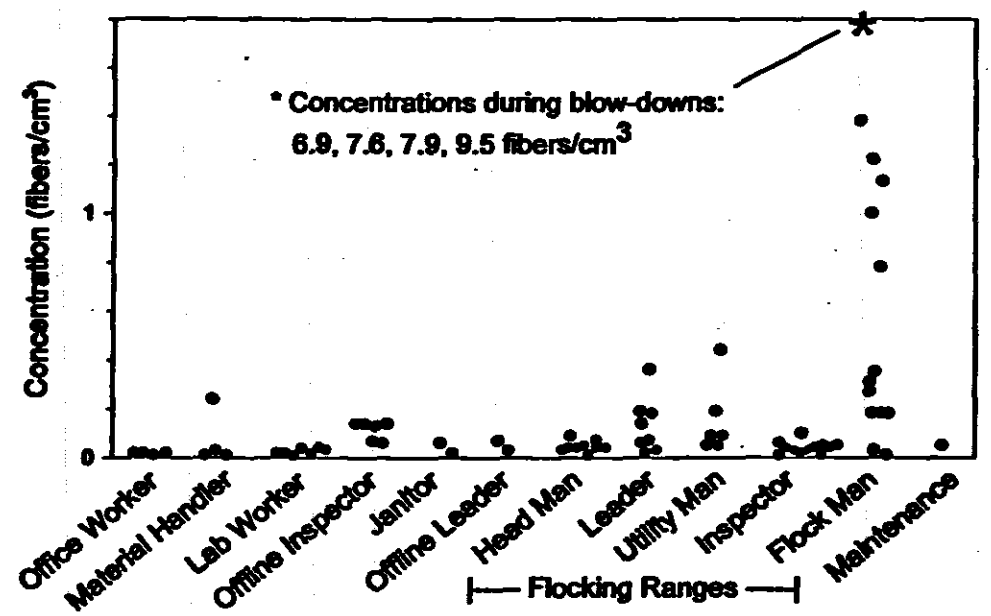


Figure 4
Real-Time Personal Dust Measurements During Flocking

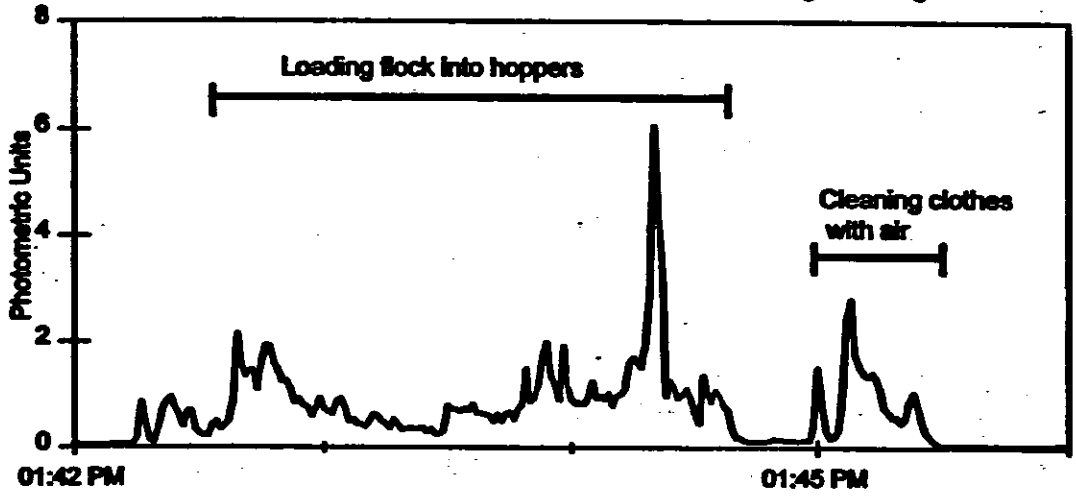


Figure 5
Real-Time Personal Dust Measurements During Blow-Down

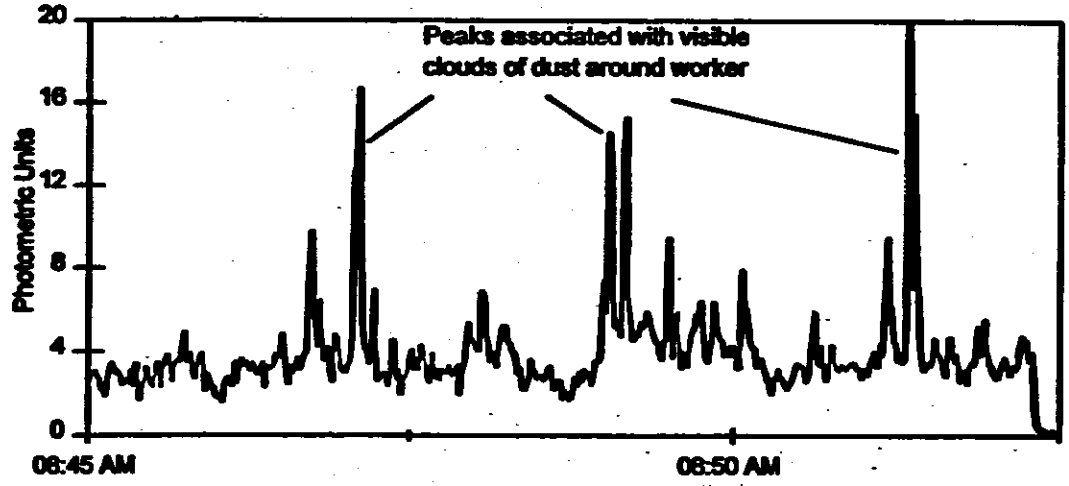
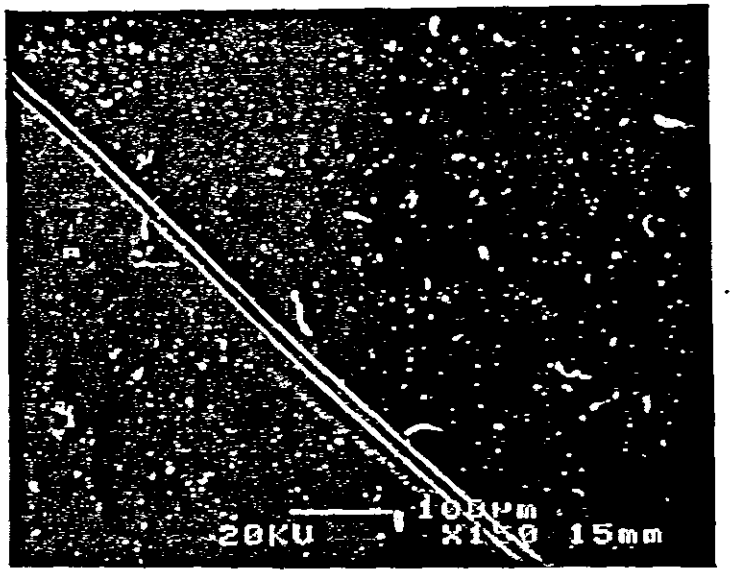


Figure 6
Scanning Electron Microscopy Image of Flocking Room Air Sample



APPENDIX

SPECTRO QUESTIONNAIRE RDHETA 98-0238

1a. Interviewer's Initials:

_____

1b. Today's Date:

_____/_____/19___

Month/ Day /, Year

1c. Plant Location: 1 Leominster (MA)

Thank you for participating in this survey. I will be collecting some information about you, your health, and your work.

_____

2a. (Last name) 2b. (First name) 2c. (MI)

_____

2d. (Street)

_____ _____ _____

2e. (City) 2f.(State) 2g. (Zip Code)

2h. (Home Phone) _____/_____-_____

2i. (Date of Birth) _____/_____/_____
(Month) (Day) (Year)

2j. (Social Security Number) _____-_____-_____

2k. (Sex) 1 Male 2 Female

2l. (Race)
1 White or Caucasian
2 African-American or Black
3 Asian
4 American Indian or Alaskan Native
5 Native Hawaiian or Other Pacific Islander
6 Other (specify)_____

B. CHEST SYMPTOMS

I am now going to ask you some questions, mainly about your chest. Please answer Yes or No. If you are in doubt about whether your answer is Yes or No, please say No.

COUGH

3a. Do you usually have a cough? This includes a cough with first smoke or on first going out-of-doors, but does not include clearing of throat. 1 Yes 2 No

If "No", skip to Question 4a (PHLEGM).
If "Yes", ask the following questions:

3b.	Do you usually cough as much as 4 to 6 times a day, for 4 or more days out of the week?	1	Yes	2	No	3	N/A
3c.	Do you usually cough like this on most days for 3 or more consecutive months during the year?	1	Yes	2	No	3	N/A
3d.	In what year did you first notice this cough?	19____					
		5555	Don't know				
		7777	N/A				

PHLEGM

4a. Do you usually bring up phlegm from your chest? This includes phlegm with a first smoke, on first going out-of-doors, and swallowed phlegm; but does not count phlegm from the nose. 1 Yes 2 No

If "No", skip to Question 5a (WHEEZING).
If "Yes", ask the following questions:

4b.	Do you usually bring up phlegm like this as much as twice a day, 4 or more days out the week?	1	Yes	2	No	3	N/A
4c.	Do you bring up phlegm like this on most days for 3 or more consecutive months during the year?	1	Yes	2	No	3	N/A
4d.	In what year did you first notice this phlegm?	19____					
		5555	Don't know				
		7777	N/A				

WHEEZING

5a. Does your chest sound wheezy or whistling occasionally apart from colds? 1 Yes 2 No

If "No", skip to Question 6a.
If "Yes", ask the following question:

5b.	In what year did you start wheezing like this?	19____	
		5555	Don't know
		7777	N/A

6a. Does your chest sound wheezy or whistling most of the time? 1 Yes 2 No

If "No", skip to Question 7a (ATTACKS OF WHEEZING).
If "Yes", ask the following question:

6b.	In what year did you start wheezing like this?	19____	
		5555	Don't know
		7777	N/A

ATTACKS OF WHEEZING

7a. Have you had an attack of wheezing that has made you feel short of breath? 1 Yes 2 No

If "No", skip to Question 8a (BREATHLESSNESS).
If "Yes", ask the following questions:

7b. In what year did you first have an attack of wheezing with shortness of breath? 19____
5555 Don't know
7777 N/A

7c. Have you ever required medicine or treatment for the(se) attack(s)? 1 Yes 2 No 3 N/A

BREATHLESSNESS

8a. Do you have any nerve, muscle, bone problems or heart trouble that makes walking difficult for you? 1 Yes 2 No

If "Yes", ask for description of difficulty:
8b._____

9a. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill? 1 Yes 2 No

If "No", skip to Section Question 10a.
If "Yes", ask the following question:

9b. In what year did you first notice this shortness of breath? 19____
5555 Don't know
7777 N/A

10a. Do you have to walk slower than people of your own age on the level because of shortness of breath? 1 Yes 2 No

If "No", skip to Section C (SYSTEMIC SYMPTOMS).
If "Yes", ask the following question:

10b. In what year did you first notice this shortness of breath? 19____
5555 Don't know
7777 N/A

C. SYSTEMIC SYMPTOMS

FEVER

11a. In the last 12 months, have you had 3 or more episodes of fever? 1 Yes 2 No

If "No", skip to Question 12a (ACHES)
If "Yes", ask the following questions:

11b. In what year did you first notice fevers like this? 19_____
5555 Don't know
7777 N/A

11c. When do you usually get these episodes of fever?
1 Usually on workdays
2 Usually on days off work
3 No noticeable pattern
4 Don't know
5 N/A

ACHES

12a. In the last 12 months, have you had 3 or more episodes of flu-like achiness or aches all over your body? 1 Yes 2 No

If "No", skip to Section D (IRRITANT SYMPTOMS).
If "Yes", ask the following questions:

12b. In what year did you first notice aches like this? 19_____
5555 Don't know
7777 N/A

12c. When do you usually get these aches?
1 Usually on workdays
2 Usually on days off work
3 No noticeable pattern
4 Don't know
5 N/A

D. IRRITANT SYMPTOMS

NOSE

13a. In the last 12 months, have you had 3 or more nosebleeds? 1 Yes 2 No

If "No", skip to Question 14a (THROAT).
If "Yes", ask the following questions:

13b. In what year did you first notice these nosebleeds? 19_____
5555 Don't know
7777 N/A

13c.	When do you usually have these nosebleeds?	1 Usually on workdays 2 Usually on days off work 3 No noticeable pattern 4 Don't know 5 N/A

THROAT

14a. In the last 12 months, have you had 3 or more episodes of throat irritation, soreness, or tickle? 1 Yes 2 No

If "No", skip to Question 15a (EYES).
If "Yes", ask the following questions:

14b.	In what year did you first notice throat irritations like this?	19____ 5555 Don't know 7777 N/A
14c.	When do you usually have this throat irritation?	1 Usually on workdays 2 Usually on days off work 3 No noticeable pattern 4 Don't know 5 N/A

EYES

15a. In the last 12 months, have you had 3 or more episodes of eye irritation? 1 Yes 2 No

If "No", skip to Question 16a (SINUS).
If "Yes", ask the following questions:

15b.	In what year did you first notice these episodes of eye irritation?	19____ 5555 Don't know 7777 N/A
15c.	When do you usually have this eye irritation?	1 Usually on workdays 2 Usually on days off work 3 No noticeable pattern 4 Don't know 5 N/A

SINUS

16a. In the last 12 months, have you had 3 or more episodes of sinus fullness, drainage, or sinus pain? 1 Yes 2 No

If "No", skip to Section E (PAST ILLNESSES).
If "Yes", ask the following questions:

16b.	In what year did you first notice these sinus symptoms?	19____ 5555 Don't know 7777 N/A
16c.	When do these sinus symptoms usually occur?	1 Usually on workdays 2 Usually on days off work 3 No noticeable pattern 4 Don't know 5 N/A

E. PAST ILLNESSES

PNEUMONIA

17a. Have you ever been told by a doctor that you had pneumonia? 1 Yes 2 No

If "No", skip to Question 18a (ASTHMA).
If "Yes", ask the following questions:

17b.	In what year did you last have pneumonia?	19____ 5555 Don't know 7777 N/A
17c.	How many episodes of pneumonia have you had in the last year?	____ episodes 00 N/A

ASTHMA

18a. Has a doctor ever told you that you have asthma? 1 Yes 2 No

If "No", skip to Question 19a (HAY FEVER).
If "Yes", ask the following questions:

18b.	At what age were you first told that you had asthma?	___ ___ (Age in years) 99 N/A
18c.	Do you still have asthma?	1 Yes 2 No 3 N/A
	If "Yes", skip to Question 19a (HAY FEVER). *If "No, ask":*	
18d.	At what age did it stop?	___ ___ (Age in years) 99 N/A

HAY FEVER

19a. Has a doctor ever told you that you have hay fever? 1 Yes 2 No

If "No", skip to Question 20a (CHEST ILLNESSES).
If "Yes", ask the following questions:

19b.	At what age were you first told you had hay fever?	___ ___ (Age in years)	99 N/A
19c.	Do you still have symptoms of hay fever?	1 Yes 2 No	3 N/A
	If "Yes", skip to Question 20a (CHEST ILLNESSES). *If "No," ask the following question:*		
19d.	At what age did you stop having hay fever symptoms?	___ ___ (Age in years)	99 N/A

CHEST ILLNESS

Have you ever had any of the following chest illnesses or conditions?

If "Yes", year most recently had:

20a. Bronchitis? 1 Yes 2 No 20b. 19___
5555 Don't know
7777 N/A

21a. Pleurisy? 1 Yes 2 No 21b. 19___
5555 Don't know
7777 N/A

22a. Tuberculosis (TB)? 1 Yes 2 No 22b. 19___
5555 Don't know
7777 N/A

23a. Heart problems? 1 Yes 2 No 23b. 19___
5555 Don't know
7777 N/A

23c. *If "Yes," ask:* What heart problems do you have? _____

24a. Chest injury? 1 Yes 2 No 24b. 19___
5555 Don't know
7777 N/A

24c. *If "Yes," ask:* What chest injury have you had? _____

24a. Chest injury? 1 Yes 2 No 24b. 19____
5555 Don't know
7777 N/A

24c. *If "Yes," ask:* What chest injury have you had?_____

F. OCCUPATIONAL HISTORY

I am now going to ask you questions about your current job

CURRENT JOB

25a. What is your current department?_____

26a. What is your current job title?_____

27a. What shift do you usually work? a Day b Night c Rotate shifts

28a. How many hours do you usually work in a week? ___ ___ Hours/Week

29a. How many days do you usually work in a week ? _____ Days/Week

BLOWDOWNS

30a. During an average week, how many blowdowns do you conduct or directly help conduct? ___ ___ ___ # of blowdowns

If "Zero", skip to Question 31a.
If a number is given, ask the following questions:

30b. Do you wear a mask or respirator when conducting a blowdown? 1 Yes 2 No 3 N/A

If "No", skip to Question 31a.
If "Yes", ask the following question:

30c. Do you wear a mask:
1 during all blowdowns?
2 during most blowdowns?
3 during some blowdowns?
4 N/A

30d. Which type of mask or respirator do you wear? (See Diagram)
01 single strap
02 2-strap
03 half face piece
04 full face piece
05 PAPR
06 SCBA

		07 other_____
		08 N/A
30e.	Were you fit tested for this respirator before you used it?	1 Yes 2 No 3 N/A

NEAR BLOWDOWNS

31a. In an average week, how many blowdowns happen near your work area that you don't directly conduct? ___ ___ ___ # of blowdowns

If "Zero", skip to Question 32a (BAG EMPTYING).
If a number is given, ask the following questions:

31b.	Do you wear a mask or respirator when these blowdowns are occurring?	1 Yes 2 No 3 N/A
	If "No", skip to Question 6 (BAG EMPTYING). *If "Yes," ask the following questions:*	
31c.	Do you wear a mask:	1 during all blowdowns 2 during most blowdowns 3 during some blowdowns 4 N/A
31d.	Which type of mask or respirator do you wear? (See Diagram)	01 single strap 02 2-strap 03 half face piece 04 full face piece 05 PAPR 06 SCBA 07 Other 08 N/A
31e.	Were you fit tested for this respirator before you used it?	1 Yes 2 No 3 N/A

BAG EMPTYING

32a. In the last 12 months, have you spent any time emptying bags of flock? 1 Yes 2 No

If "No", skip to Question 33a (ALL MATERIALS)
If "Yes", ask the following questions:

32b.	In an average shift, how many hours do you spend emptying bags of flock?	___ ___ hours in a shift 99 N/A

32c.	Do you wear a mask or respirator while you are emptying bags? *If "No", skip to Question 33a (ALL MATERIALS)* *If "Yes," Ask the following questions:*	1 Yes 2 No 3 N/A
32d.	When do you wear the mask or respirator?	1 during all bag emptying 2 during most bag emptying 3 during some bag emptying 4 N/A
32e.	Which type of mask or respirator do you wear? (See Diagram)	01 single strap 02 2-strap 03 half face piece 04 full face piece 05 PAPR 06 SCBA 07 Other _____ 08 N/A
32f.	Were you fit tested for this respirator before you used it?	1 Yes 2 No 3 N/A

ALL MATERIALS

33a. Have you noticed that any materials at work cause you to have chest symptoms such as cough, phlegm, wheezing, attacks of wheezing, or shortness of breath? 1 Yes 2 No

If "No", skip to Question 35a.
If "Yes", list the Material(s) and Symptom(s):

33b. Material _____ 33c. Symptom _____

33d. Material _____ 33e. Symptom _____

33f. Material _____ 33g. Symptom _____

33h. Material _____ 33i. Symptom _____

In the past 12 months have you worked on the range, module, dye house or bagging station with the following materials:

	EVERY MONTH in the last 12 months	LESS THAN EVERY MONTH in the last 12 months	NEVER in the last 12 months
34a. NYLON	1	2	3
34b. RAYON	1	2	3
34c. POLYESTER	1	2	3
34d. COTTON	1	2	3
34e. ARAMID	1	2	3
34f. ACRYLIC	1	2	3

G. CIGARETTE SMOKING

Now I would like to ask you about cigarette smoking.

35a. Have you ever smoked cigarettes regularly? Please say "Yes" if you have smoked 100 cigarettes or more in your entire life. (100 cigarettes = 5 packs) — 1 Yes 2 No

If "No", skip to Section H (WORK HISTORY)
If "Yes", ask the following questions:

35b.	How old were you when you first started smoking cigarettes regularly?	___ ___ (Age in years)	99 N/A
35c.	On average, for the entire time that you smoked, how many cigarettes did you smoke per day? (20 cigarettes = 1 pack)	___ ___ ___ (# Cigs/day)	999 N/A
35d.	Do you now smoke cigarettes (as of 1 month ago)? *If "Yes," skip to Section H. (WORK HISTORY)* *If No ask:*	1 Yes 2 No	3 N/A
35e.	If you have stopped smoking cigarettes completely, how old were you when you stopped?	___ ___ (Age in years)	99 N/A

H. WORK HISTORY

36. WORK HISTORY– for all jobs that you have had for 6 months or more , please list employer, industry, jobs with that employer and time spent in the office. Start with your current employer and work back in time.

Employer	Industry	Date started (mo/yr)	Date Stopped (mo/yr)	Jobs/job titles with this employer	% of time of average work shift spent in the office in this job	reason left employer

Thank you for your participation!

For Information on Other Occupational Safety and Health Concerns

Call NIOSH at:
1-800-35-NIOSH (356-4676)
or visit the NIOSH Homepage at:
http://www.cdc.gov/niosh/homepage.html

National Institute for Occupational Safety and Health
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